EFFECTS OF BETA-RADIATION ON GROWTH AND PHOTOSYNTHESIS IN SEEDLINGS OF *ARABIDOPSIS THALIANA* AFTER EXPOSURE TO ^{90}Sr

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Introduction

Human activities have led to increased antropogenic releases of radionuclides to the environment in liquid discharges of nuclear power plants and the NORM-industry, e.g. phosphate mining and processing facilities. Very often, plants are, through irrigation or direct exposure in an aquatic environment, the first contact between effluents and the biosphere. Although a large amount of research has been done on uptake and effects, especially on the genetic level, of radionuclides in plants for heavily contaminated sites such as the Chernobyl area, the biological effects of radionuclides and in particular their effects in combination with heavy metals present in the environment remain poorly characterized for most plant species. Furthermore, little is known on the dose-effects relation of alpha-, beta- and gamma-radiation in plants, as well as the physiological mechanisms of stress response due to these different types of radiation.

Here, we investigate the effects of beta-radiation on the model plant *Arabidopsis thaliana* in a single stressor set-up with ^{90}Sr as beta-emitting radionuclide, with the aim to establish a dose-effect curve for beta-radiation based on several morphological and physiological endpoints.

Methods

We exposed 18-day-old seedlings of *Arabidopsis thaliana* for 96 hours to ^{90}Sr, administered under the form of $SrCl_2$ in standard Hoagland medium through a hydroponic setup [1]. Solution activities used were 0, 40, 400, 4000, 40000 and 200000 Bq/L. The actual strontium concentrations remained several orders of magnitude below those known to be chemotoxic to plants.

After exposure, plants were harvested, and fresh weight of root and shoot tissues were measured. The plant material was then dried and dry weight percentage calculated. For each treatment, uptake of strontium into the plant and transfer from root to shoot tissues were calculated. Photosynthetic condition was assessed by measuring induction and rapid light curves on freshly harvested leaves, using Pulse-Amplitude Modulated (PAM) fluorometry [2,3].

Results and Discussion

The uptake of ^{90}Sr by the plant was found to be linear with increasing solution concentration for the entire range of treatments, indicating that visibly no saturation mechanism was activated by the exposure. We found average transfer factors (TF) for ^{90}Sr of 262 ± 1.2 for the shoots and 38.4 ± 0.6 for root tissues (both fresh weight based). The resulting calculated internal dose rate to be 20 mGy h^{-1} in the highest treatment averaged over the entire plant. In the leaves, this dose rate amounted to 35 mGy h^{-1}. These data confirm earlier studies that observe a high mobility of strontium towards and between plant tissues [4], due to its resemblance to calcium.

Root nor shoot biomass were found to be singificantly affected by ^{90}Sr exposure. Dry weight percentage did not significantly differ for either tissue type or treatment.

Indicators of photosynthetic condition, such as the widely used Fv/Fm and Φ_{II} (photosynthetic yield), showed no significant differences throughout the different exposure conditions, despite the high dose rate in the leaf tissues. To look for differences in photosynthesis dynamics, we modelled non-photochemical quenching (NPQ) dynamics during induction of dark-adapted leaves as well as the changes in electron transfer rate (ETR) of photosystem II in rapid light curves, as they can provide information about condition of the physiological mechanisms behind photosynthesis [5]. However, no effect on these parameters could be distinguished between treatments.

Although 18-day old seedlings did not show effects for the different growth and photosynthesis parameters monitored, it is possible that the exposure to ionizing radiation has resulted in DNA damage. On-going analysis of the samples therefore focusses on the localization and quantification of DNA damage and repair in the different tissues, to see if a response can be detected at the molecular level. In addition we will expose plants at different early developmental stages to radiation as age is very likely to be a crucial factor in the magnitude at which effects are elicited [6]. Once a more sensitive growth stage is determined, we will move on to an in-depth analysis of the dose-response relation for *Arabidopsis* exposed to different radiation types.

Bibliography

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